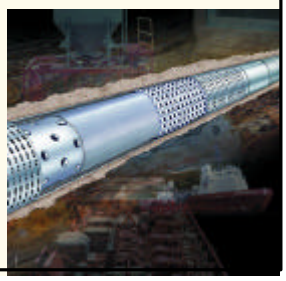
Horizontal Gravel Packs



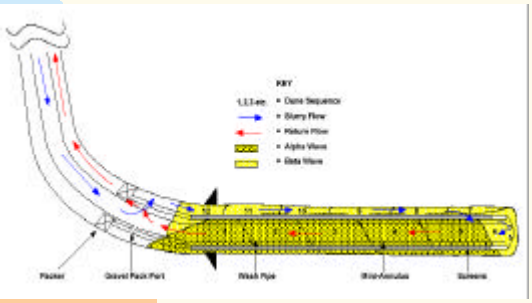
Outline

- Introduction
- Circulating path in a standard gravel pack
- Some history
- Project planning and execution
- Limitations of horizontal gravel packs in ERD wells
- Future challenges

Introduction

- Gravel packing is a commonly applied technique to control formation sand production from open-hole oil and gas wells.
- In a gravel pack completion, a screen is placed in the well across the productive interval and specially sized, high permeability gravel pack sand is mixed in a carrier fluid and circulated into the well to fill the annular space between the screen and formation.

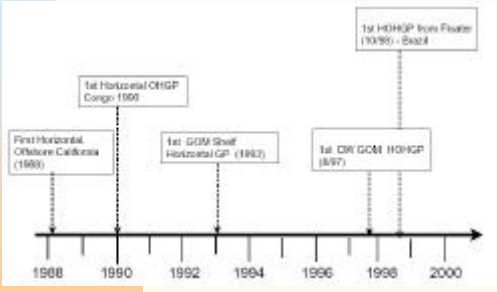
A basic gravel pack circulating path



Openhole horizontal gravel packing

- OHHGP has gained acceptance as a mainstay completion technique.
- Projected reliability and the potential to achieve significantly higher sustainable production rates have been the major drivers for pursuing this type of completion.
- Interval lengths in excess of 2500 feet are now fairly common, with the current record being 6,938 feet in a well completed in the North Sea by the Texaco North Sea UK Company.

Some history



The demand of new technology:

- Deepwater completions of high volume producers (>15,000 BOPD or >70 MMscf/D) in the GOM with a well life up to 15 years became a major challenge for the industry.
- Increased reliability was needed for the openhole screened completions, and OHHGP was the answer to the problems experienced.
- Some of the difficulties that were encountered will be discussed here

Key issues in project planning and execution openhole horizontal gravel packs:

- Reservoir study
- Shale stability study
- Formation integrity test
- Gravel pack sand sizing
- Gravel pack screen
- Workstring design
- Well displacement
- Fluid loss control

Issues that can jeopardize performance of successful OHHGP

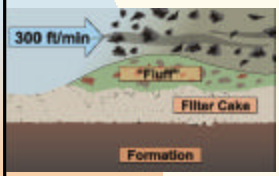
- Excessive fluid loss
- Varying hole geometry that could lead to premature pack termination
- Hole stability issues leading to hole collapse
- A narrow pressure spread between bottomhole pressure and fracture gradient

Limitations of Extended-Reach Horizontal Gravel Packs

- The Beta-wave (return gravel wave) placement pressure is the main factor in determining the maximum length of a horizontal gravel pack.
- This pressure is limited by the requirement to install the gravel pack without exceeding formation fraction pressure.

Beta-wave Pressure Control

High Rate Well displacement to remove fluff



- Circulating brine at high velocity provides optimum hole cleaning.
- Ensures that drill solids and dynamic filter cake material (fluff) is circulated out.
- The remaining filter cake should be thin and extremely durable.

Future challenges

- New invert gravel pack fluid that has the potential to save rig time by reducing costly OB to WB fluid swaps, and also eliminates the need for acid treatment after pack placement.
- Advancement in tool technology that reduce bottomhole circulating pressure during placement of the sand pack using the Alpha/Beta placement method.

Cont'd

- Advancements in tool technology that allow multiple functions during a single trip of the workstring.
- Advances in screen systems that provide the capability to isolate and pack around shale sections as well as the capability to place the gravel pack while encountering fluid loss.

Final comments

- In the future, the newly developed expandable screen systems may also provide an alternative to horizontal openhole gravel packing.
- In a demanding environment such as deepwater, technology must continue to evolve to meet the need for long term reliability and high productivity.
- It is difficult to say whether one of these technologies will emerge as the dominant technology.